Hyperbaric Oxygen in Therapy of Gas Gangrene

Report of a Case Following Induced Abortion

KARL L. SCHAUPP, JR., M.D., DOUGLAS PINTO, M.D., AND
RODNEY J. VALENTINE, M.D., *San Francisco*

■ *The treatment of gas gangrene has been revolutionized by oxygen drenching of tissues infected with Clostridia. This was used in a massive infection of the abdominal wall following a traumatic abortion attempt. The clostridial infection was controlled, but the patient almost succumbed to a secondary infection of gram-negative organisms. This responded to drainage, antibiotics and general supportive measures. In the course of treatment, the value of a team approach to complicated special problems was documented.*

AS RECENTLY AS 1962 acute, progressive infection with *Clostridium perfringens* (welchii) was considered inevitably fatal unless the infected tissue was completely removed, regardless of what auxiliary therapeutic agents were used or in what amounts they were administered.[7] The organism is a spore-bearing obligatory anaerobic bacillus which produces a number of toxins which are exo-enzymes. The bacillus itself is of a saprophytic nature and it is the toxin production which creates its micro-environment and makes it lethal. Anaerobic conditions, necrotic tissue, poor blood supply and foreign bodies are factors that contribute to an environment favorable for aggressive reproduction of the organism.

The mere presence of the bacillus is not proof of infection. MacLennan[7] described three clinical situations from which the organism could be recovered: Simple contamination without infection, anaerobic cellulitis and anaerobic myonecrosis. Only the latter is considered true gas gangrene. A high proportion (27 per cent) of women in a state of abortion have *Cl. perfringens* in high vaginal swabs.[9] The organism is universally present in the bowel and in 8 to 10 per cent of normal vaginas, but it is an incidental finding in cases other than those with myonecrosis.

Chairman's address: Presented before the Section on Obstetrics & Gynecology at the 95th Annual Session of the California Medical Association, Los Angeles, 19 to 23 March 1966.

Reprint requests to: 490 Post Street, San Francisco, California 94102 (Dr. Schaupp).

Surgical excision of infected tissue has been the mainstay of treatment to present times. In wounds, this means amputation of limbs and extensive mutilating operation. In the uterus, hysterectomy has been lifesaving. Kadner and Anderson[6] reviewed the reported cases since 1950 and added seven more in 1963. Some of these were not unequivocal cases of myonecrosis. In 1965 Browne[2] reported two cases which followed cesarean section. Hysterectomy was lifesaving.

In 1961 Brummelkamp[3] reported experimental evidence and three cases showing the value of drenching the tissues with oxygen. This was done by having the patient breathe 100 per cent oxygen under a pressure of three atmospheres (absolute) for two hours with five to seven sessions in three days. The hemoglobin saturation is not changed by this, but the amount dissolved physically in the plasma is increased 15 times. The oxygen available in this solution finds its way into the infected area and interferes with the metabolic processes of the anaerobic *Cl. perfringens*. This stops the toxin production which is necessary to maintain the micro-environment of the organism. It does not kill the organism, and living bacilli have been recovered from clinically healed deep wounds.[4] Smith[8] reported three cases in 1962, but considered the oxygen therapy only as an aid to the usual surgical measures and to administration of penicillin and antitoxin. Boerma,[1] taking note of

Smith's report, said that oxygen drenching was lifesaving, permitting conservatism in surgical measures and saving extremities from amputation. Jackson[5] in 1965 reported a case of abdominal wall infection following bowel resection. In spite of heroic measures, the infection progressed beyond surgical reach and the patient was apparently doomed until hyperbaric oxygen was remembered and appropriate treatment effected a cure. It is interesting to note that Browne's cases[2] were presented in late 1965 and no mention was made of oxygen therapy.

Report of a Case

In the afternoon of 30 December 1964 a 27-year-old white woman, para 2, was admitted to hospital with a diagnosis of acute pelvic inflammatory disease following an abortion 36 hours previously. The patient was far sicker than expected, and the passage of a foul-smelling macerated fetus about 18 cm long prompted a review of what had happened. With mistaken dates in mind (last menstrual period 15 November 1964) the patient had been aborted by someone not aware of the existence of a twin. The procedure had taken two hours and was obviously traumatic. A pack was inserted and the patient sent home. The pack had been removed in 12 hours.

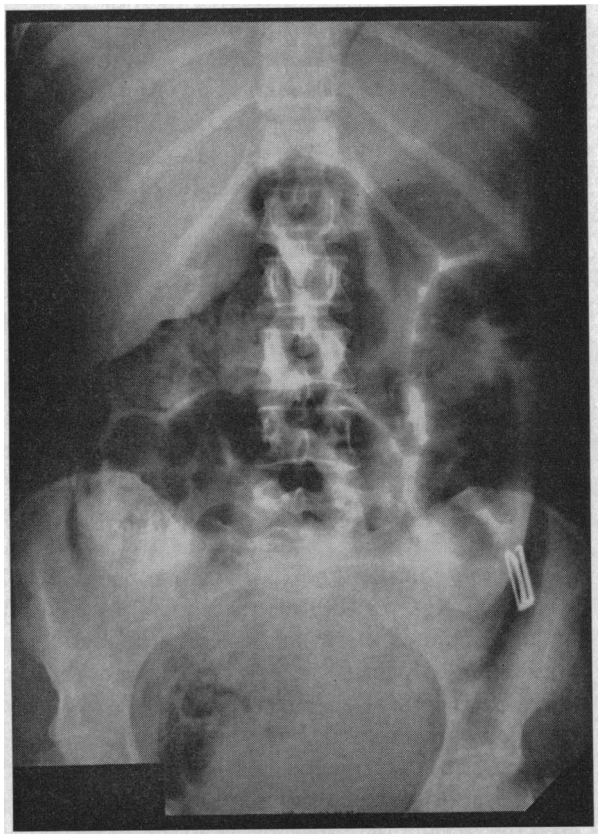

Figure 1.—Film of abdomen on admission. Note extraperitoneal gas under metal clip and in corresponding area on the right. Also, foamy mass in pelvis.

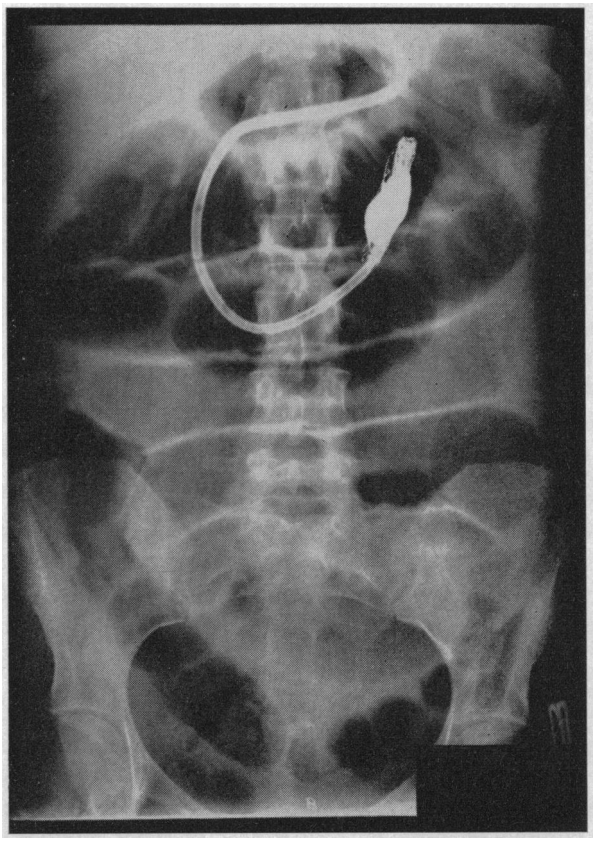

Figure 2.—Massive distension on third day. Note long tube in duodenum. Extraperitoneal gas still present.

On physical examination the patient appeared extremely ill. The temperature was 37.6°C (99.7°F), pulse 120, respiration 18 and blood pressure 105/50 mm of mercury. The abdominal wall was rigid and there was a bronze discoloration of the lower abdomen. There was decided abdominal tenderness and no bowel sounds. The cervix was open and showed ecchymosis on the anterior lip. A culture was taken from the cervical discharge. The blood showed a hemoglobin of 9.9 gm per 100 ml and packed cell volume of 30 per cent. Leukocytes numbered 18,100 per cu mm. Upright and decubitus x-ray films showed gas in tissue planes of the lower abdomen and a foamy mass in the pelvis (Figure 1).

Administration of fluids by vein and of penicillin and streptomycin was begun. In a few hours, the culture confirmed the source of the gas in the tissues as *Cl. perfringens* and the patient was promptly

transferred to Presbyterian Medical Center for hyperbaric oxygen therapy. The urinary output was low and the patient had hypotension. She was placed in the oxygen chamber at 11:45 a.m. and given 50 minutes of 100 per cent oxygen at three atmospheres (absolute) of pressure. An intravenous cutdown was placed to manage fluid and electrolyte balance. A Foley catheter and a nasogastric tube were inserted. Penicillin G, to which the organism was sensitive, was given in a dose of 60 million units daily in the intravenous fluids. Streptomycin, 0.5 gm intramuscularly twice daily, was also given. The oxygen therapy was repeated at 9:30 p.m. At 11:30 p.m. the patient passed a foul-smelling placenta 8×10×2 cm. Cultures from it contained *Cl. perfringens.*

The following day the oxygen therapy was repeated twice. The uterus was explored with the patient in bed and only a few small fragments of tissue and 30 ml of straw-colored fluid were recovered. Two units of whole blood were given with continuing fluid and electrolyte balance. The plasma hemoglobin was 14 mg per 100 ml and the urinary hemoglobin 1.3 mg, indicating hemolysis. The abdomen was distended and the patient was disoriented. On the third day the same regimen was continued (without oxygen therapy) but pronounced distension raised the question of mechanical bowel obstruction (Figure 2). Placement of a long tube helped improve the condition and the patient passed some flatus. The temperature and pulse rate were down (Chart 1). On the fourth day the patient was improved, but the following day jaundice was noted and a sudden rise in temperature to 38.9°C (102°F) occurred in the evening (Chart 1). Two units of whole blood were included in the fluids.

On the sixth day it was thought there was an increase in the extraperitoneal gas as seen roentgenographically. As this was considered due to a reactivation of the *Cl. perfringens,* hyperbaric oxygen therapy was begun again. Because there was no response, colymycin and methicillin were given in the next two days. Streptomycin was discontinued. Three units of blood were used.

On the ninth day the patient was in critical condition. There was low output of urine and she was hypotensive. On aspiration in the right lower quadrant of the abdomen, a tan fluid was withdrawn which showed gram-negative rods on stain-

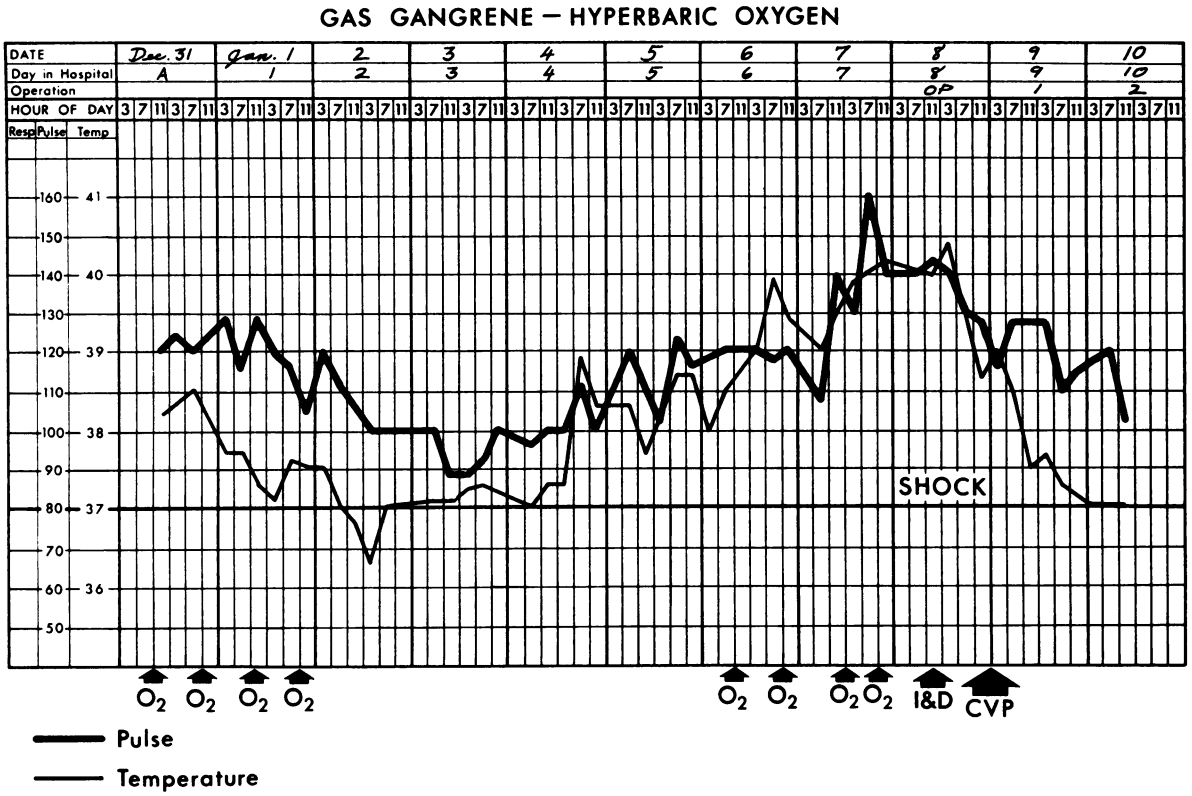

Chart 1.—Graphic record of critical times in the course of the infection. O_2=hyperbaric oxygen. I & D=incision and drainage. CVP=central venous pressure.

ing. Cultures showed *E. coli* and *Bacteroides*. With this evidence the patient was taken to the operating room and a large incision made down to the preperitoneal space in each lower quadrant. The peritoneum was surrounded by a foul-smelling abscess cavity as far up as the umbilicus and down into the pelvis. The levator on the right was found perforated, with a tract leading to a bulla on the right lateral perineal area. This was incised. Necrotic tissue was removed from the incision on the right. The patient was in shock. She received seven units of whole blood, some of it under pressure. A central venous pressure catheter was placed through the right external jugular vein to monitor the amount of blood needed. Penicillin was discontinued and chloramphenicol started at a dose of 500 mg intramuscularly every six hours. The next day the temperature and the pulse rate fell dramatically (Chart 1). The urine output was only 150 ml in 24 hours. Blood clotting was poor and calcium gluconate was given intravenously. The patient was jaundiced. One unit of blood was given and another the next day. Urine output increased and diuresis occurred on the 12th day. Jaundice was decreasing. Fluids by mouth were started on the 13th day and food intake was increased to a regular diet with beginning ambulation in the next few days.

On the 15th day the antibacterial action of the patient's serum against E. coli cultured from the uterus was 1:8. On the day before the test, she had received 60 million units of penicillin, 300 mg of colymycin and 500 mg of chloramphenicol. The chloramphenicol was discontinued the next day.

Seventeenth day: A small infra-umbilical incision was made into a small abscess. Irrigations were begun with 500 mg of neomycin in 1,000 ml of normal saline solution. The irrigation solution would flow from the upper incision to the inguinal incisions and through to the drainage wound in the right perineal area. The foul-smelling drainage improved immediately.

Twenty-second day: Penicillin G was started in a dose of 600,000 units intramuscularly every eight hours. Benemid, 0.5 gm, was given by mouth with each dose. This was continued for 10 days along with the irrigations, and the temperature gradually decreased to normal. The wounds cleared and granulations formed. The patient was dismissed 10 February 1965 with a Foley catheter in the bladder, as she could not void.

She was examined occasionally as an outpatient. Some bladder tone returned and the Foley tube was removed. At last report the wounds were healed but there was some loss of tone of the abdominal muscles, although they functioned adequately. The bladder and bowel were hypnotic, but functioned with special attention. Apparently menses appeared three to four months after dismissal. After menstruation was late in one cycle, sequential hormonal therapy was begun. This has not produced further bleeding. The patient is functioning normally and is working at her former job as a receptionist.

Discussion

The problems presented in this case needed the special knowledge and techniques of experts in general surgery, internal medicine, bacteriology and gynecology. As in many other areas of medicine, the team approach was the only rational way to offer a desperately ill patient the best chance for survival. One of the main aims of modern practitioners of medicine should be to know generally what current scientific advances have been made, and then make them available to the patient. This means calling specially qualified consultants in time.

To summarize briefly, the patient had an overwhelming infection with *Cl. perfringens* which responded dramatically to hyperbaric oxygen therapy. A second wave of Gram-negative invaders then took over the abscess cavity which was ideal for their propagation. This caused shock, anuria, hemolysis and jaundice. Administration of antibiotics, hyperbaric oxygen, fluid and blood and maintenance of electrolyte balance barely kept the patient alive until the cavity was incised and drained. This was the second critical turning point and the patient then began to recover.

The problem of one infection following the other is common in gas gangrene, as the infections are mixed. Oxygen drenching should be used as soon as possible, but adequate debridement and drainage along with appropriate antibiotics and general support are also of utmost importance.

ADDENDUM: The patient was seen at Presbyterian Medical Center in the spring of 1966 for cosmetic revision of scars from the previous procedures. The organs, viewed through a reopened incision in the right inguinal area, appeared normal. The patient still had not menstruated since the time of the last previous observation, but she was contemplating marriage.

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